Ionized-gas kinematics in very metal-poor dwarf galaxies and implications for star formation triggers

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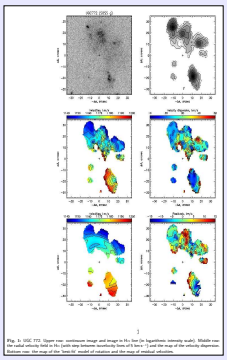
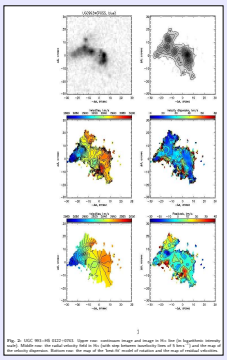
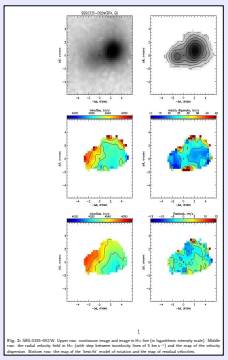
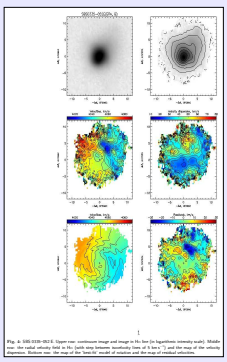
Abstract

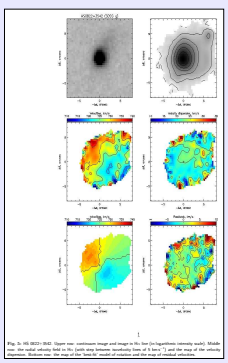
The study of ionized gas morphology and kinematics in nine eXtremely Metal-Deficient (XMD) galaxies with the SAO 6-m telescope scanning Fabry-Perot interferometer (FPI) is presented. Some of these very rare objects (with currently known range of O/H of $7.12 < 12+\log(O/H) < 7.65$, or $Z_\odot/35 < Z < Z_\odot/10$) are believed to be the best proxies of 'young' low-mass galaxies in the high-redshift Universe. One of the main goals of this study was to look for possible evidence of the star formation (SF) activity, induced by external perturbations. The recent results of a small subsample of XMD star-forming galaxies HI mapping provided the confident evidence on the important role of the interaction-induced SF in this group. Our new FPI data give for the great majority of the studied XMD dwarfs a complementary or new information with further evidence on strongly disturbed gas morphology and kinematics or the presence of detached components. We approximate the observed velocity fields by simple models of a rotating tilted thin disc, which allow robustly significant separation of strong kinematic disturbances. These data, in turn, indicate the important role of current/recent interactions and mergers in the observed enhanced star formation. The by-product results, obtained for the LSB dwarf galaxy SAO 0822+3545, show the off-center asymmetric low SFR star-forming regions, likely induced by the interaction with the companion XMD dwarf HS 0822+3542.

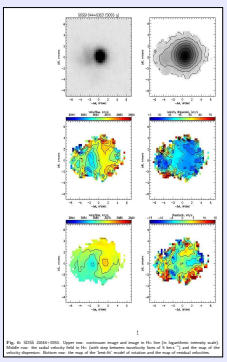


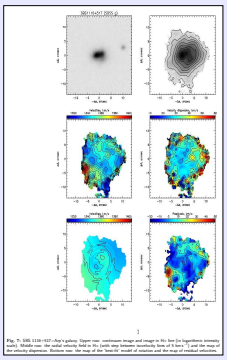


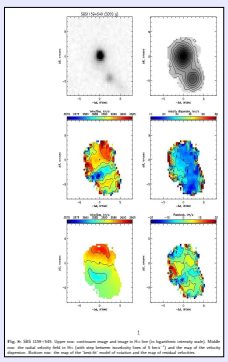


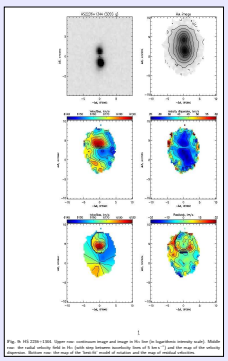


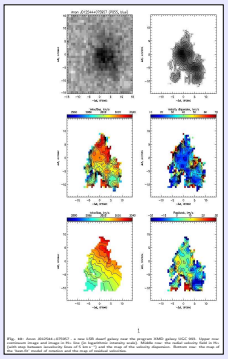


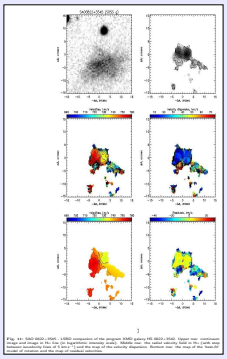












Results

1. The ionized gas kinematics in very low-metallicity star-forming galaxies, collected in this study, as visible from our FPI Hα observations, is significantly disturbed and rarely can be well fitted by the overall regular rotation.
2. Several of our galaxies show more or less clear evidence from both, the morphology and Hα velocity fields, for various stages of mergers (UGC 993, SDSS J1044+0353, SBS 1116+517, SBS 1159+545, HS 2236+1344).
3. In other galaxies the rotation component of the overall velocity field is more important, but disturbances appear to be large enough, and the residuals of the 'best-fit' rotation model imply either recent merger, or sufficiently strong disturbance by nearby galaxies (HS 0822+3542 and UGC 772).
4. The interacting/merging nature of the 'binary' system of well separated XMD galaxies SBS 0335–052E and W is best evident from their HI morphology and kinematics data. Despite a relatively large mutual distance, the tidal action of each component to the other clearly affects the gas dynamics of these very gas-rich objects and triggers the current SF burst and very likely the previous major SF episode. To understand this unique interacting system, a nice representative of high-redshift young galaxies, in more detail, one needs a wide grid of models of interacting gas-rich galaxies, like 'Identikit', but including SF processes.
5. The Hα morphology and velocity fields for two LSB dwarfs, Anon J012544+075957 and SAO 0822+3545, companions of two program XMD galaxies, are obtained and analysed. They can be used in statistical studies of SF in LSB dwarfs. The star formation in SAO 0822+3545 is highly asymmetric and takes place mainly in two knots at the northern edge, that is likely induced by the recent interaction with the nearby XMD BCG HS 0822+3542.
6. In general, the results of our FPI study of the ionized gas kinematics in the subsample of nine XMD star-forming galaxies, along with the complementary results of the GMRT HI study of a part of these galaxies, indicate that strong interactions and mergers of dwarf galaxies are the major or significant factors triggering their current and recent starbursts.

The paper is submitted to MNRAS.